

Assessment report No:
NIE: 55472RAN.002

Assessment report RF EXPOSURE REPORT ACCORDING TO FCC 47 CFR Part 2.1091 ISED RSS -102 Issue 5:2015

Identification of item tested.....:	Automotive infotainment System
Trademark	BMW
Model and /or type reference	MGU
Other identification of the product	FCC ID: T8GMGU IC: 6434A-MGU
Final HW version	1.4
Final SW version	A415_17w46.1-2
Features	Bluetooth, WLAN, GNSS.
Manufacturer	HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH BECKER-GOERING-STR. 16; 76307 KARLSBAD GERMANY
Test method requested, standard.....:	FCC 47 CFR Part 2.1091 Radiofrequency radiation exposure evaluation: mobile devices. ISED RSS-102 Issue 5 (2015-03) – Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
Summary	IN COMPLIANCE
Approved by (name / position & signature)	Miguel Lacave Antennas Lab Manager
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Identification of the client

HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH
BECKER-GOERING-STR. 16; 76307 KARLSBAD GERMANY

General description of the device under evaluation

The device under assessment consists of an automotive head unit to be installed in cars with the following features: Bluetooth, WLAN and GNSS.

The device has two radiating antennas, according to the manufacturer, the minimum separation distance between the radiating antennas and the driver, or anyone inside the car, will be more than 20 cm. In order to perform the assessment, a more conservative distance of 20 cm has been used for the calculations.

The equipment specifications declared by the manufacturer for each supported feature are:

Ant	Band (MHz)	Technology	Maximum E.I.R.P. (dBm)
Ant 1	2402-2480	Bluetooth	10.0
	5170-5825	802.11a/n/ac	20.0
Ant 2	2412-2472	802.11b/g/n	20.0
	5170-5825	802.11a/n/ac	20.0

Table 1: Equipment specifications

Assessment summary

Radiofrequency radiation exposure limits			
FCC 47 CFR § 2.1091 & ISED RSS-102 Issue 5 (2015-03)			
Band (MHz)	Technology	Band	VERDICT (Pass/Fail)
2412-2477	802.11b/g/n	ISM	Pass
5170-5825	802.11a/n/ac	5 GHz	Pass
2402-2480	Bluetooth	ISM	Pass

Table 2: Assessment summary

Appendix A – FCC RF Exposure

FCC RF Exposure evaluation for mobile devices

Devices operating in standalone mobile device exposure conditions may contain a single transmitter or multiple transmitters that do not transmit simultaneously. A minimum test separation distance ≥ 20 cm is required between the antenna and radiating structures of the device and nearby persons to apply mobile device exposure limits. The distance must be at least 20 cm and fully supported by the operating and installation configurations of the transmitter and its antenna(s), according to the source-based time-averaged maximum power requirements of § 2.1091(d)(2). In cases where cable losses or other attenuations are applied to determine compliance, the most conservative operating configurations and exposure conditions must be evaluated. The minimum test separation distance required for a device to comply with mobile device exposure conditions must be clearly identified in the installation and operating instructions, for all installation and exposure conditions, to enable users and installers to comply with RF exposure requirements. For mobile devices that have the potential to operate in portable device exposure conditions, similar to the configurations described in § 2.1091(d)(4), a KDB inquiry is required to determine the SAR test requirements for demonstrating compliance.

When a device qualifies for the categorical exclusion provision of § 2.1091(c), the minimum test separation distance may be estimated, when applicable, by simple calculations according to plane-wave equivalent conditions, to ensure the transmitter and its antenna(s) can operate in manners that meet or exceed the estimated distance. The source-based time-averaged maximum radiated power, according to the maximum antenna gain, must be applied to calculate the field strength and power density required to establish the minimum test separation distance. When the estimated test separation distance becomes overly conservative and does not support compliance, MPE measurement or computational modeling may be used to determine the required minimum separation distance.

According to §1.1310 Radiofrequency radiation exposure limits, paragraph (e), the limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields are:

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposure				
0.3–3.0	614	1.63	* 100	6
3.0–30	1842/f	4.89/f	* 900/f ²	6
30–300	61.4	0.163	1.0	6
300–1,500 .....	.....	.....	f/300	6
1,500–100,000 .....	.....	.....	5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	* 100	30
1.34–30	824/f	2.19/f	* 180/f ²	30
30–300	27.5	0.073	0.2	30
300–1,500 .....	.....	.....	f/1500	30
1,500–100,000 .....	.....	.....	1.0	30

f = frequency in MHz * = Plane-wave equivalent power density

FCC MPE Evaluation Results

Each supported transmission technology will be evaluated to determine if it is in compliance with limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields.

In order to perform the assessment, the following equations have been used for the calculations; these equations are accurate in the far-field of an antenna but will over-predict power density in the near field, where they could be used for making a "worst case" or conservative prediction:

$$\text{Power density: } S[mW / cm^2] = \frac{P_{E.I.R.P.}[mW]}{4\pi R[cm]^2}$$

$$\text{Minimum compliance distance: } R_{\min}[cm] = \sqrt{\frac{P_{E.I.R.P.}[mW]}{4\pi S[mW / cm^2]}}$$

Where:

S = power density

$P_{E.I.R.P.}$ = Equivalent isotropically radiated power

R = distance to the center of radiation of the antenna (evaluation distance)

R_{\min} = distance to the center of radiation of the antenna

Assessment 1 – 802.11 b/g/n – 2450 MHz

Minimum use distance (cm):	20.0
Worst Case Frequency (MHz):	2412
Maximum EIRP (dBm):	20.0
Maximum EIRP (mW):	100.0
General population - Power density limit (mW/cm ²):	1.0

Power density at minimum use distance:

Power density (mW/cm ²):	0.02
General population - Power density limit (mW/cm ²):	1.0
Verdict for general population:	PASS

The power density level for this transmission mode is below general population exposure power density limit.

Minimum compliance distance for this technology:

Minimum distance for general public (cm):	2.82
Minimum use distance (cm):	20.0
Verdict for general population :	PASS

The minimum use distance is greater than general population exposure minimum compliance distance.

Assessment 2 – 802.11a/n/ac – 5 GHz

Minimum use distance (cm):	20.0
Worst Case Frequency (MHz):	5170
Maximum EIRP (dBm):	20.00
Maximum EIRP (mW):	100
General population - Power density limit (mW/cm ²):	1.0

Power density at minimum use distance:

Power density (mW/cm ²):	0.02
General population - Power density limit (mW/cm ²):	1.0
Verdict for general population:	PASS

The power density level for this transmission mode is below general population exposure power density limit.

Minimum compliance distance for this technology:

Minimum distance for general population (cm):	2.82
Minimum use distance (cm):	20.0
Verdict for general population:	PASS

The minimum use distance is greater than general population exposure minimum compliance distance.

Assessment 3 – Bluetooth – 2450 MHz

Minimum use distance (cm):	20.0
Worst Case Frequency (MHz):	2402
Maximum EIRP (dBm):	10.00
Maximum EIRP (mW):	10.00
General population - Power density limit (mW/cm ²):	1.0

Power density at minimum use distance:

Power density (mW/cm ²):	0.002
General population - Power density limit (mW/cm ²):	1.0
Verdict for general population:	PASS

The power density level for this transmission mode is below general population exposure power density limit.

Minimum compliance distance for this technology:

Minimum distance for general population (cm):	0.89
Minimum use distance (cm):	20.0
Verdict for general population:	PASS

The minimum use distance is greater than general population exposure minimum compliance distance.

Multiple frequencies assessment

When multiple sources are introduced into an environment, it becomes necessary to address the sources interdependently, since each source will contribute some percentage of the maximum exposure toward the total exposure at a fixed location. The sum of the ratios of the exposure from each source to the corresponding maximum exposure for the frequency of each source must be evaluated.

The exposure complies with the maximum permissible exposure if the sum of the ratios is less than unity:

$$\sum_{i=1}^n \frac{S_i}{MPE_i} < 1$$

Where

S_i is the power density of each source;

MPE_i is the power density basic restriction of each source.

The device is able to transmit using both antennas at the same time, the worst case combination will be:

Ant 1 (BT) + Ant 1 (WLAN 5 GHz) + Ant 2 (WLAN 2.45 GHz)

$$\frac{0.002 + 0.02 + 0.02}{1} = 0.042 < 1 \text{ Limit}$$

Appendix B – ISED RF Exposure

ISED RF Exposure evaluation for mobile devices

According to RSS-102 Issue 5, Paragraph “4. Exposure Limits”, Industry of Canada has adopted the RF field strength limits established in Healths Canada’s RF exposure guideline, Safety code 6:

**Table 4: RF Field Strength Limits for Devices Used by the General Public
 (Uncontrolled Environment)**

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Reference Period (minutes)
0.003-10 ²¹	83	90	-	Instantaneous*
0.1-10	-	0.73/ <i>f</i>	-	6**
1.1-10	87/ <i>f</i> ^{0.5}	-	-	6**
10-20	27.46	0.0728	2	6
20-48	58.07/ <i>f</i> ^{0.25}	0.1540/ <i>f</i> ^{0.25}	8.944/ <i>f</i> ^{0.5}	6
48-300	22.06	0.05852	1.291	6
300-6000	3.142 <i>f</i> ^{0.3417}	0.008335 <i>f</i> ^{0.3417}	0.02619 <i>f</i> ^{0.6834}	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/ <i>f</i> ^{1.2}
150000-300000	0.158 <i>f</i> ^{0.5}	4.21 x 10 ⁻⁴ <i>f</i> ^{0.5}	6.67 x 10 ⁻⁵ <i>f</i>	616000/ <i>f</i> ^{1.2}
Note: <i>f</i> is frequency in MHz. *Based on nerve stimulation (NS). ** Based on specific absorption rate (SAR).				

ISED MPE Evaluation Results

Each supported transmission technology will be evaluated to determine if it is in compliance with RSS-102 Issue 5, RF Field Strength Limits for devices used by the General Public.

In order to perform the assessment, the following equations have been used for the calculations; these equations are accurate in the far-field of an antenna but will over-predict power density in the near field, where they could be used for making a "worst case" or conservative prediction:

$$\text{Power density: } S[W/m^2] = \frac{P_{E.I.R.P.}[W]}{4\pi R[m]^2}$$

$$\text{Minimum compliance distance: } R_{\min}[m] = \sqrt{\frac{P_{E.I.R.P.}[W]}{4\pi S[W/m^2]}}$$

Where:

S = power density

$P_{E.I.R.P.}$ = Equivalent isotropically radiated power

R = distance to the center of radiation of the antenna (evaluation distance)

R_{\min} = distance to the center of radiation of the antenna

Assessment 1 – 802.11b/g/n – 2450 MHz

Minimum use distance (m):	0.2
Worst Case Frequency (MHz):	2412
Maximum EIRP (dBm):	20.0
Maximum EIRP (W):	0.10
General public - Power density limit (W/m ²):	5.36

Power density at minimum use distance:

Power density (W/m ²):	0.20
General public - Power density limit (W/m ²):	5.36
Verdict for general public:	PASS

The power density level for this transmission mode is below general public power density limit.

Minimum compliance distance for this technology:

Minimum distance for general public (m):	0.039
Minimum use distance (m):	0.2
Verdict for general public:	PASS

The minimum use distance is greater than general public minimum compliance distance.

Assessment 2 – 802.11a/n/ac – 5 GHz

Minimum use distance (m):	0.2
Worst Case Frequency (MHz):	5170
Maximum EIRP (dBm):	20.0
Maximum EIRP (W):	0.10
General public - Power density limit (W/m ²):	9.04

Power density at minimum use distance:

Power density (W/m ²):	0.20
General public - Power density limit (W/m ²):	9.04
Verdict for general public:	PASS

The power density level for this transmission mode is below general public power density limit.

Minimum compliance distance for this technology:

Minimum distance for general public (m):	0.03
Minimum use distance (m):	0.2
Verdict for general public:	PASS

The minimum use distance is greater than general public minimum compliance distance.

Assessment 3 – Bluetooth – 2450 MHz

Minimum use distance (m):	0.2
Worst Case Frequency (MHz):	2402
Maximum EIRP (dBm):	10.0
Maximum EIRP (W):	0.01
General public - Power density limit (W/m ²):	5.35

Power density at minimum use distance:

Power density (W/m ²):	0.02
General public - Power density limit (W/m ²):	5.35
Verdict for general public:	PASS

The power density level for this transmission mode is below general public power density limit.

Minimum compliance distance for this technology:

Minimum distance for general public (m):	0.012
Minimum use distance (m):	0.2
Verdict for general public:	PASS

The minimum use distance is greater than general public minimum compliance distance.

Multiple frequencies assessment

When multiple sources are introduced into an environment, it becomes necessary to address the sources interdependently, since each source will contribute some percentage of the maximum exposure toward the total exposure at a fixed location. The sum of the ratios of the exposure from each source to the corresponding maximum exposure for the frequency of each source must be evaluated.

The exposure complies with the maximum permissible exposure if the sum of the ratios is less than unity:

$$\sum_{i=1}^n \frac{S_i}{MPE_i} < 1$$

Where

S_i is the power density of each source;

MPE_i is the power density basic restriction of each source.

The device is able to transmit using both antennas at the same time, the worst case combination will be:

Ant 1 (BT) + Ant 1 (WLAN 5 GHz) + Ant 2 (WLAN 2.45 GHz)

$$\frac{0.02}{5.35} + \frac{0.2}{9.04} + \frac{0.2}{5.36} = 0.063 < 1 \text{ Limit}$$